Effect of Vitamin D Deficiency on Pulmonary Function Test in a Normal Population

Hemin Khalid Saber, Hamanejm Faraj Jaff, Media Qader Hasan[1]

Department of Internal Medicine, College of Medicine, Hawler Medical University, [1]Department of Family Medicine, Kurdistan Board for Medical Specialty (KBMS), Erbil, Iraq

Abstract

Background: During the past years, the role of Vitamin D on wide biologic processes has received the attractiveness. Moreover, the role of Vitamin D in the prevention and treatment of respiratory infections has already been confirmed. **Objective:** In the present study, the pulmonary functions, including forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1) ratio, and FEV1/FVC ratio were compared between healthy individuals with and without Vitamin D deficiency. **Materials and Methods:** In the current case–control study, the pulmonary functions of healthy individuals with normal Vitamin D (control = 51) and with Vitamin D deficiency (cases = 57) were compared through statistical analysis. The individuals recruited in the study were screened from the outpatient clinic of medicine department of a public hospital purposively. The Vitamin D level <50 nmol/L was considered deficient. The reference values of pulmonary functions were considered as follows: FVC between 80% and 120% as normal and <80% as reduced; FEV1 ≥75 as normal and <75 as reduced; FEV1/FVC between 80% and 120% as normal. **Results:** The present study showed that individuals with normal level of Vitamin D (control) and those with deficient level of Vitamin D (case) were comparable in age (39.09 vs. 41.33 years; $P = 0.393$), and body mass index (27.48 vs. 28.39; $P = 0.475$), respectively. In addition, both case and control groups were similar in FVC (93.98 vs. 93.12; $P = 0.653$), FEV1 (90.88 vs. 89.39L; $P = 0.752$), and FEV1/FVC (95.94 vs. 95.01%; $P = 0.777$) respectively. **Conclusion:** The study did not show a significant difference in baseline characteristics and of those spirometry functions (FVC, FEV1, and FEV1/FVC) between the healthy individuals with normal and deficient Vitamin D levels.

Keywords: Healthy individuals, pulmonary functions, Vitamin D

Introduction

During the past years, the role of Vitamin D on wide biologic processes, including antiproliferative and antiapoptotic effect,[1,2] cardiovascular diseases prevention,[1] modulating immunity,[2,3] and autoimmune diseases prevention[3,4] has received the attractiveness. Moreover, the role of Vitamin D in the prevention and treatment of respiratory infections has already been confirmed.[5,6]

Recently, some papers suggested an association between serum Vitamin D level and the pulmonary functions in adult and children.[7-9] For example, a study examined the prevalence of Vitamin D deficiency and insufficiency and risk factors of exacerbation in chronic obstructive pulmonary disease (COPD) patients. They reported that >80% of the patients have reduced levels of Vitamin D and among those patients >40% had Vitamin D insufficiency (defined as 25–0 nmol/L) and >40% had Vitamin D deficiency (<25 nmol/L). Vitamin D levels were significantly correlated with quality of life and lung functions. The Vitamin D deficiency was determined to be a risk factor for a longer hospital stay.[9]

In addition, some studies had reported that the consumption of Vitamin D supplements could be a protective factor against moderate-to-severe exacerbation in patients with COPD.[10,11] Despite a wide variety of studies on the impacts of Vitamin D deficiency on exacerbation in patients with respiratory diseases,[12-14] there are few studies in healthy individuals.

The effectiveness of the lungs functions is evaluated through the pulmonary function tests (PFTs). Spirometry is the most commonly used test in this regard. The test is so simple,

Access this article online

Quick Response Code:

Website: www.medjbabylon.org

DOI: 10.4103/MJBL.MJBL_75_18

Address for correspondence: Dr. Hemin Khalid Saber, Department of Internal Medicine, College of Medicine, Hawler Medical University, Erbil, Iraq.
E-mail: hemin.khalid@nur.hmu.edu.krd

How to cite this article: Saber HK, Jaff HF, Hasan MQ. Effect of Vitamin D deficiency on pulmonary function test in a normal population. Med J Babylon 2019;16:51-4.

easily available, and has a good sensitivity, and specificity for interpretation of algorithms.

The aim of this study was to evaluate the differences in pulmonary functions between healthy individuals with normal Vitamin D levels and those with deficient Vitamin D levels.

Materials and Methods

Study design and sampling

The individuals were selected from the internal medicine department of Rizgari Teaching Hospital between March and November 2017 in Erbil city, Kurdistan region, Iraq, following taking ethical approval from Kurdistan Board for Medical Specialties and consent forms from all patients.

In the present study, the individuals who enrolled in this study were among those who consecutively visited the internal medicine of a general hospital (Rizgary teaching hospital) for the medical respiratory check-up were screened for the Vitamin D assessment. The individuals with Vitamin D deficient were considered as cases and those with normal Vitamin D as a control. The healthy individuals without having any pulmonary diseases were matched in age and gender. Pulmonary functions of the healthy individuals enrolled in this study including forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), and FEV1/FVC ratio were measured.

The individuals met eligibility criteria if they were healthy male or female, aged 18 years and older, and irrespective of sociodemographic perspectives. The pregnant individuals and those with the previous history of respiratory diseases (since the last year); current and ex-smokers since the past 15 years; some other medical conditions such as asthma and chronic instructive pulmonary disease (COPD), cardiovascular and muscular diseases; or were taking Vitamin D supplements were excluded from the study.

Diagnostic and measurement criteria

The general aspects of the individuals, including age (year), gender (male/female), residency (urban/rural), and chronic disease (yes/no), occupation (manual, professional, retired, or student) were reported. Body mass index (BMI) was measured by dividing weight in Kg by squared height in meter. The BMI <18.5 was considered as underweight, BMI 18.5–24.9 as normal weight, BMI 25–30 as overweight, BMI > 30 as obese.

Enzyme-linked immunosorbent assay was performed for assessment of 25-hydroxyvitamin D (25[OH]D) level. The Vitamin D <50 nmol/L was considered as deficient as ≥50 nmol/L as normal. The persons were asked to perform the spirometry tests, including FVC, FEV1, and FEV1/FVC ratio. The amount of air that each person breathes in and out was measured by a spirometer using new Spirolab from the Medial International Research for Pulmonary Function Tests for a PFT. The persons were asked to sit in front of a spirometer.

A technician asked the person to breathe in and out as deeply or as quickly as he can for several seconds. The PFT was measured by the authors of the study. FEV1 is the volume of air that can forcibly be blown out in 1 s, after full inspiration, FVC, which is the amount of air that can be forcefully expelled from the lungs as a function of time, beginning at maximal inhalation (termed total lung capacity), and ending when the lungs are emptied to their minimal volume (residual volume). Pulmonary function then was measured and their reference values were considered as normal or reduced if the FVC is between 80% and 120% or <80%, respectively, whereas it is normal or reduced if the FEV1 ≥75% or <75%, respectively. FEV1/FVC ratio ≥80% or <80% was considered as normal or reduced, respectively.[15]

Ethical considerations

The official ethical clearance of the present investigation was obtained from the Kurdistan Board for Medical Specialties and the written consent forms were obtained from all individuals before participation in the study. The present study did not have any harm to participants as no intervention was applied to the participants. The guarantee was given to the participants for the confidentiality of their personal information.

Statistical analysis

The descriptive purposes of the study were examined in frequency distribution whether frequency and percentage or mean and standard deviation. The difference in baseline characteristics and pulmonary functions between participants with normal and deficient Vitamin D was examined through an independent *t*-test, Chi-square test, or Fishers exact test. The null hypothesis was rejected in a $P < 0.05$. The statistical calculations were performed using the Statistical Package for the Social Sciences version 25 (SPSS, IBM Company, Chicago, USA).

Results

The study showed that the participants in both groups of the study were comparable in age ($P = 0.393$), BMI ($P = 0.475$), BMI categories ($P = 0.263$), and chronic disease ($P = 0.601$), sex ($P = 0.170$), and occupation ($P = 0.648$). While the majority of the participants of both groups live in urban areas ($P = 0.039$) [Table 1].

The difference in pulmonary functions is illustrated in Table 2. The study did not show a significant difference in FVC ($P = 0.653$), FEV1 ($P = 0.752$), and FEV1/FVC ($P = 0.777$).

Discussion

The Vitamin D has various roles in etiological connections with respiratory health such as its role in fetal lung development and impacts on normal immune functioning.[16,17]

The results found that there is no significant difference in pulmonary functions, including, FVC, FEV1, FEV1/FVC ratio, and PFT between individuals with normal and deficient levels of Vitamin D.

Table 1: Baseline characteristics between participants with normal and deficient vitamin D

Characteristics (n=108)	Vitamin D deficient (*n*=57)	Vitamin D normal (*n*=51)	*P* (two-sided)
Age (year)	39.09±14.18	41.33±13.00	0.393*
BMI	27.48±6.07	28.39±7.10	0.475*
Sex			
Male	26 (45.6)	30 (58.8)	0.170**
Female	31 (54.4)	21 (41.2)	
BMI categories			
Under weight	0 (0.0)	2 (4.2)	0.263***
Normal	19 (36.5)	15 (31.3)	
Over weight	21 (40.4)	13 (27.1)	
Moderately obese	8 (15.4)	12 (25.0)	
Severely obese	2 (3.8)	5 (10.4)	
Morbid obesity	2 (3.8)	1 (2.1)	
Residential area			
Urban	34 (59.6)	41 (80.4)	0.039**
Rural	9 (15.8)	6 (11.8)	
Subdural	14 (24.6)	4 (7.8)	
Chronic disease	1 (1.8)	2 (3.9)	0.601***
Occupation			
Manual	28 (49.1)	27 (54.0)	0.648**
Professional	15 (26.3)	9 (18.0)	
Retired	7 (12.3)	5 (10.0)	
Student	7 (12.3)	9 (18.0)	

*Independent *t*-test, **Chi-square test, ***Fisher's exact test were performed for statistical analyses. The bold number shows the significant difference. BMI: Body mass index

Table 2: Pulmonary functions between participants with normal and deficient vitamin D

Characteristics (*n*=108)	Vitamin D deficient (*n*=57)	Vitamin D normal (*n*=51)	*P* (two-sided)
FVC (L)	93.98±20.84	93.98±20.84	0.653*
Normal	40 (70.2)	31 (60.8)	0.471**
Reduced	12 (21.1)	12 (23.5)	
Increased	5 (8.8)	8 (15.7)	
FEV1 (L)	90.88±25.01	89.39±23.61	0.752*
Normal	46 (80.7)	42 (82.4)	0.502***
Increased	4 (7.0)	1 (2.0)	
Reduced	7 (12.3)	8 (15.7)	
Ratio	95.94±17.44	95.01±16.59	0.777*
Normal	50 (87.7)	43 (84.3)	0.609**
Reduced	7 (12.3)	8 (15.7)	

*Independent *t*-test, **Chi-square test, ***Fisher's exact test were performed for statistical analyses. FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s

It has been confirmed that serum Vitamin D abnormalities are associated with wide health outcomes, such as respiratory illness and a reduction in lung function.[18] However, there is a debate in the literature as a number of confounders have not been considered in these studies.[18,19]

The possible role of Vitamin D deficiency in respiratory diseases has been approved in the literature. For example, Shaheen *et al*.[7] conducted a cross-sectional study to examine the relationship of dietary Vitamin D intake, serum 25(OH)D concentrations, and three Vitamin D receptor polymorphisms with lung functions in patients aged 59–73 years with COPD. They found that Vitamin D intake is positively associated with FEV1, FEV1/FVC, and negatively with COPD. The similar findings were reported by Mekov *et al*.[9] in patients with COPD for the risk due to Vitamin D deficiency and insufficiency. This kind of association has been found in another respiratory disease as well as[20,21] even the conflicting results were reported.[22,23]

The deficiency of Vitamin D in healthy individuals has received little attention in the literature. To the best of our knowledge, Mulrennan *et al*.[24] are the only one who have been focused on the association of Vitamin D levels and respiratory functions in aged healthy (aged 45–69 years) individuals. They showed that the persons with vitamin D>100 nmol/L had a higher FVC with adjustment for gender, BMI, and history of chronic disease (1.17% higher compared to the 50-100 nmol/L with adjustment for history of chronic diseases). Vitamin D (25OHD) <50 nmol/L was shown to associate with asthma (odds ratio: 1.32; 95% confidence interval: 1.00, 1.73), bronchitis (1.54; 1.17, 2.01), wheeze (1.37; 1.10, 1.71), and chest tightness (1.42; 1.10, 1.83).

Strengths and limitations of the study

The strong point of the present study can be traced in the presence of a gap of Vitamin D deficiency and pulmonary functions in the literature. However, the findings reported by the present investigation must be interpreted with caution as the study sample has been recruited from one region precluding us to generalize the findings to other settings.

Conclusion

The present study did not find that the healthy individuals with Vitamin D deficiency have a lower value in FVC, FEV1, FEV1/FVC, and PFT.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Moreno J, Krishnan AV, Feldman D. Molecular mechanisms mediating the anti-proliferative effects of Vitamin D in prostate cancer. J Steroid Biochem Mol Biol 2005;97:31-6.
2. Raiten DJ, Picciano MF. Vitamin D and health in the 21st century: Bone and beyond. Executive summary. Am J Clin Nutr 2004;80:1673S-7S.
3. Holick MF. Sunlight and Vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. Am J Clin Nutr 2004;80:1678S-88S.
4. Munger KL, Levin LI, Hollis BW, Howard NS, Ascherio A. Serum 25-hydroxyvitamin D levels and risk of multiple sclerosis. JAMA 2006;296:2832-8.
5. Wang TT, Nestel FP, Bourdeau V, Nagai Y, Wang Q, Liao J, *et al*. Cutting edge: 1,25-dihydroxyvitamin D3 is a direct inducer of antimicrobial peptide gene expression. J Immunol 2004;173:2909-12.

6. Coussens AK, Wilkinson RJ, Hanifa Y, Nikolayevskyy V, Elkington PT, Islam K, *et al.* Vitamin D accelerates resolution of inflammatory responses during tuberculosis treatment. Proc Natl Acad Sci U S A 2012;109:15449-54.
7. Shaheen SO, Jameson KA, Robinson SM, Boucher BJ, Syddall HE, Sayer AA, *et al.* Relationship of Vitamin D status to adult lung function and COPD. Thorax 2011;66:692-8.
8. Yao TC, Tu YL, Chang SW, Tsai HJ, Gu PW, Ning HC, *et al.* Serum 25-hydroxyvitamin D levels in relation to lung function and exhaled nitric oxide in children. J Pediatr 2014;165:1098-30.
9. Mekov E, Slavova Y, Tsakova A, Genova M, Kostadinov D, Minchev D, *et al.* Vitamin D deficiency and insufficiency in hospitalized COPD patients. PLoS One 2015;10:e0129080.
10. Lehouck A, Mathieu C, Carremans C, Baeke F, Verhaegen J, Van Eldere J, *et al.* High doses of Vitamin D to reduce exacerbations in chronic obstructive pulmonary disease: A randomized trial. Ann Intern Med 2012;156:105-14.
11. Martineau AR, James WY, Hooper RL, Barnes NC, Jolliffe DA, Greiller CL, *et al.* Vitamin D3 supplementation in patients with chronic obstructive pulmonary disease (ViDiCO): A multicentre, double-blind, randomised controlled trial. Lancet Respir Med 2015;3:120-30.
12. Calvo MS, Whiting SJ, Barton CN. Vitamin D intake: A global perspective of current status. J Nutr 2005;135:310-6.
13. Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA, *et al.* Global Vitamin D status and determinants of hypovitaminosis D. Osteoporos Int 2009;20:1807-20.
14. Palacios C, Gonzalez L. Is Vitamin D deficiency a major global public health problem? J Steroid Biochem Mol Biol 2014;144 Pt A: 138-45.
15. Pérez LL. Office spirometry. Osteopath Fam Physician 2013;5:65-9.
16. Schwalfenberg GK. A review of the critical role of Vitamin D in the functioning of the immune system and the clinical implications of Vitamin D deficiency. Mol Nutr Food Res 2011;55:96-108.
17. Zosky GR, Hart PH, Whitehouse AJ, Kusel MM, Ang W, Foong RE, *et al.* Vitamin D deficiency at 16 to 20 weeks' gestation is associated with impaired lung function and asthma at 6 years of age. Ann Am Thorac Soc 2014;11:571-7.
18. Autier P, Boniol M, Pizot C, Mullie P. Vitamin D status and ill health: A systematic review. Lancet Diabetes Endocrinol 2014;2:76-89.
19. Finklea JD, Grossmann RE, Tangpricha V. Vitamin D and chronic lung disease: A review of molecular mechanisms and clinical studies. Adv Nutr 2011;2:244-53.
20. Beyhan-Sagmen S, Baykan O, Balcan B, Ceyhan B. Association between severe Vitamin D deficiency, lung function and asthma control. Arch Bronconeumol 2017;53:186-91.
21. Litonjua AA. Vitamin D levels, asthma, and lung function: Time to act on deficiency? J Allergy Clin Immunol Pract 2017;5:797-8.
22. Kunisaki KM, Niewoehner DE, Singh RJ, Connett JE. Vitamin D status and longitudinal lung function decline in the lung health study. Eur Respir J 2011;37:238-43.
23. Holmgaard DB, Mygind LH, Titlestad IL, Madsen H, Fruekilde PB, Pedersen SS, *et al.* Serum Vitamin D in patients with chronic obstructive lung disease does not correlate with mortality – Results from a 10-year prospective cohort study. PLoS One 2013;8:e53670.
24. Mulrennan S, Knuiman M, Walsh JP, Hui J, Hunter M, Divitini M, *et al.* Vitamin D and respiratory health in the busselton healthy ageing study. Respirology 2018;23:576-82.